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THE PRODUCTION OF THE TITANIUM OXIDE BANDS IN THE ELECTRIC FURNACE

In view of the prominence of the titanium oxide bands in the spectra of later-type stars, some recent experiments on the production of these bands in the electric furnace may be of interest. These experiments included the production of the bands at temperatures ranging from 1900° to 2500° C, and demonstrated the much greater efficacy of the action of free oxygen on titanium as compared with the use of prepared titanium oxide. This oxide was in the form of a white powder and of high purity. It was used with the furnace in vacuum and at atmospheric pressure, and also when white light was passed through the tube to give absorption spectra. The stronger bands were visible at temperatures from 1900° to 2000° C and were of considerable intensity at 2250°, especially with the short exposures required for absorption spectra. An emission spectrum at 2500° with the oxide in the vacuum furnace showed no trace of bands, while the titanium lines were as strong as in a normally exposed arc spectrum. The results indicated a rapid dissociation of the oxide, as the low-temperature lines $\lambda\lambda$ 5174, 5193, 5210 were invariably stronger than the superposed band with head at λ 5167. Frequent renewals of the supply of oxide did not suffice to give an intensity of the bands comparable to that obtained when metallic titanium was melted in the furnace in vacuum and then, with the furnace open, a stream of oxygen was passed through the tube. A temperature of about 1900° appeared again to be the lower limit for the appearance of the bands, which were then stronger than any lines in the region from the green to the red. At higher temperatures, with a stream of oxygen, a mixed spectrum of bands and lines appeared, until at 2450° the bands were of extreme brilliancy. By increasing the flow of oxygen it was possible to enhance the bands at the expense of the lines; in fact, with a very large supply of oxygen the lines were practically eliminated.

The experiments thus far have not indicated what the upper temperature limit for the production of bands may be when abundance of oxygen is present. The work has confirmed the results of a former investigation (*Ap. Jour.,* **43,** 1916) for the higher temperatures, as it was then shown that 2300° was a favorable temperature for the bands with either air or oxygen passing through the tube, though the bands were still strong at 2600°. At 2500° to 2600° the more rapid vaporization of the titanium, by increasing the density of the emitting molecules, may have much to do with the great strength of the bands.

Arthur S. King.

Spectroscopic Observations of R Scuti

Espin[1] noted changes in the spectrum of this irregular variable more than thirty years ago when he observed visually that the bands changed considerably in intensity and almost disappeared at times. A series of plates taken at the Lick Observatory in 1903 by R. H. Curtiss[2] showed the presence of bright hydrogen lines at the maximum of light in July of that year.

During the years 1921 and 1922, a number of spectrograms of this star have been secured with the sixty-inch reflector on Mount Wilson. The star is of especial importance because its period ,though irregular to a considerable degree, ranges from 100 to 150 days, and is thus intermediate between the long and short period variables, and because it furnishes an example of the periodic recurrence of the titanium oxide bands in a spectrum which would otherwise be classed as G or K.

The table gives a list of the plates, the dates and the visual magnitudes taken from a curve representing the observations of this star published by the American Association of Variable Star Observers, except for the last three which were derived by extrapolation from the curve with the aid of estimates of the brightness of the star made during the observation at the spectroscope. The fourth column gives the spectral type excluding the bands from consideration, while the fifth gives the strength of the titanium bands on a scale which is used here for subdividing the spectral class M into ten subdivisions depending on the strength of the bands. The next three columns indicate the character and relative intensity of the hydrogen lines on the dif-

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[1] *M.,N.* **51,** 12, 1890.
[2] *Lick Observatory Bulletin,* **3,** 41, 1904.